



Unit Testing Framework for Operating System Kernels

Walter, Maxwell; Karlsson, Sven

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Unit Testing Framework for Operating System Kernels

Maxwell Walter and Sven Karlsson
Technical University of Denmark



Problem

- We need a way to test a new OS kernel as it is being developed
 - Before hardware drivers are fully implemented
 - With multiple different hardware setups
- Current methods rely on manual information retrieval

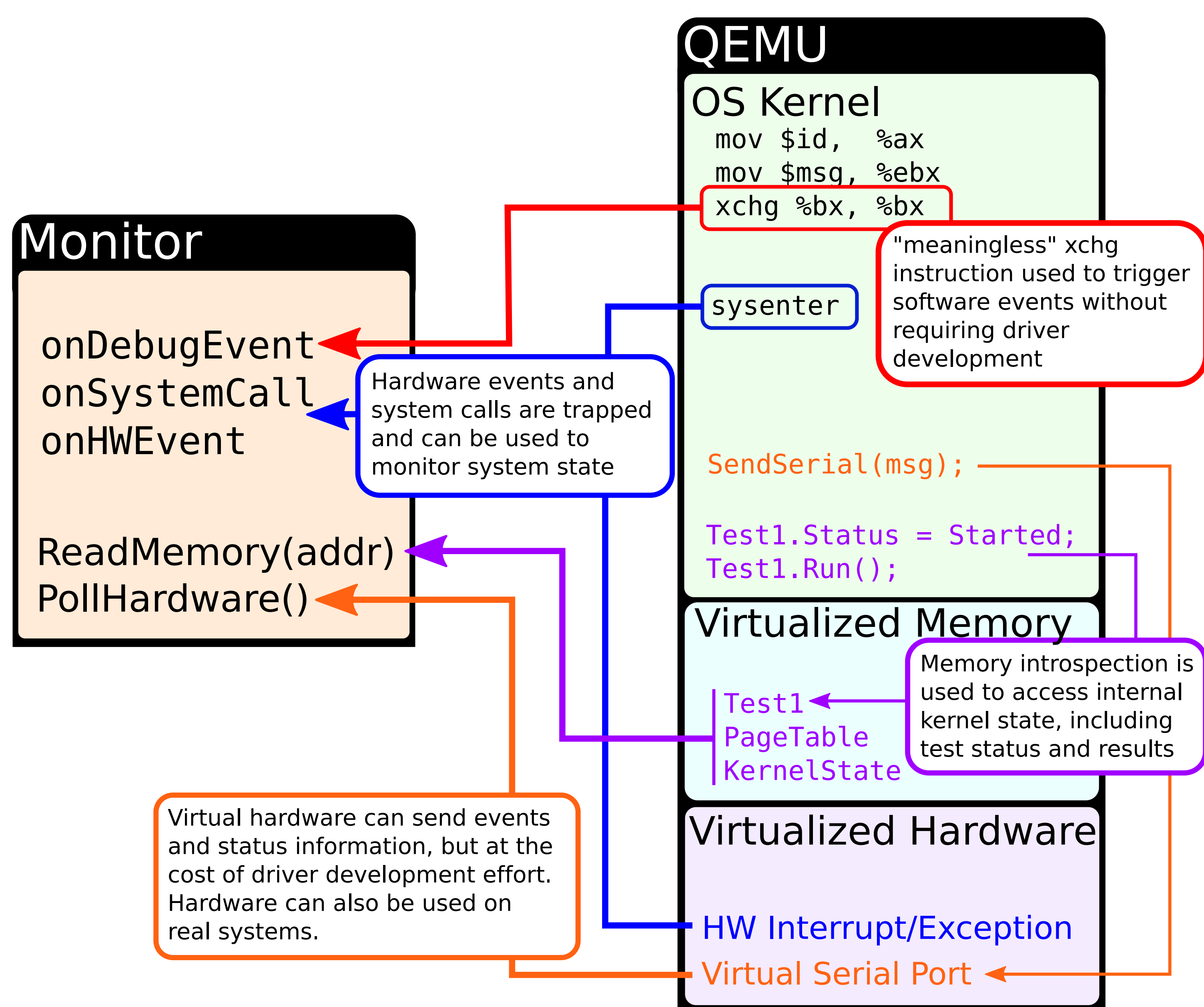
Approach

- Run the OS kernel in a **virtual machine** (VM)
 - Use **QEMU** as our virtualization platform
 - Create virtual hardware configurations as needed
 - Use virtual machine introspection (VMI) to access internal state
- Create an in-kernel **Testing API** that
 - Provides a way to create, start, and report on tests
 - Provides software test points for VMI

Contributions

- A **testing framework** for operating system kernels consisting of
 - A management interface for testing HW configurations
 - A test monitor interface for accessing kernel and VM state
 - An in-kernel testing API

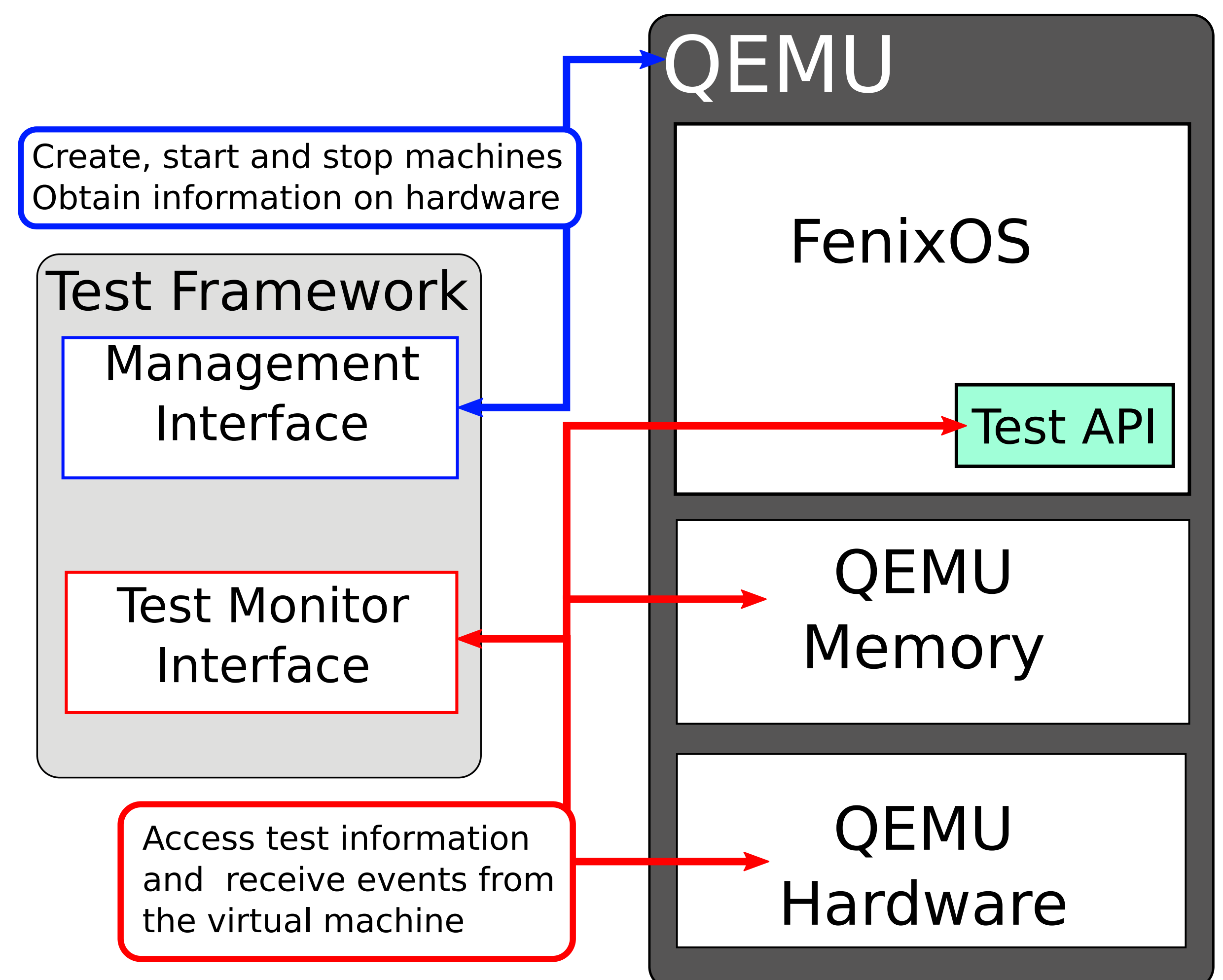
Framework and VM Communication



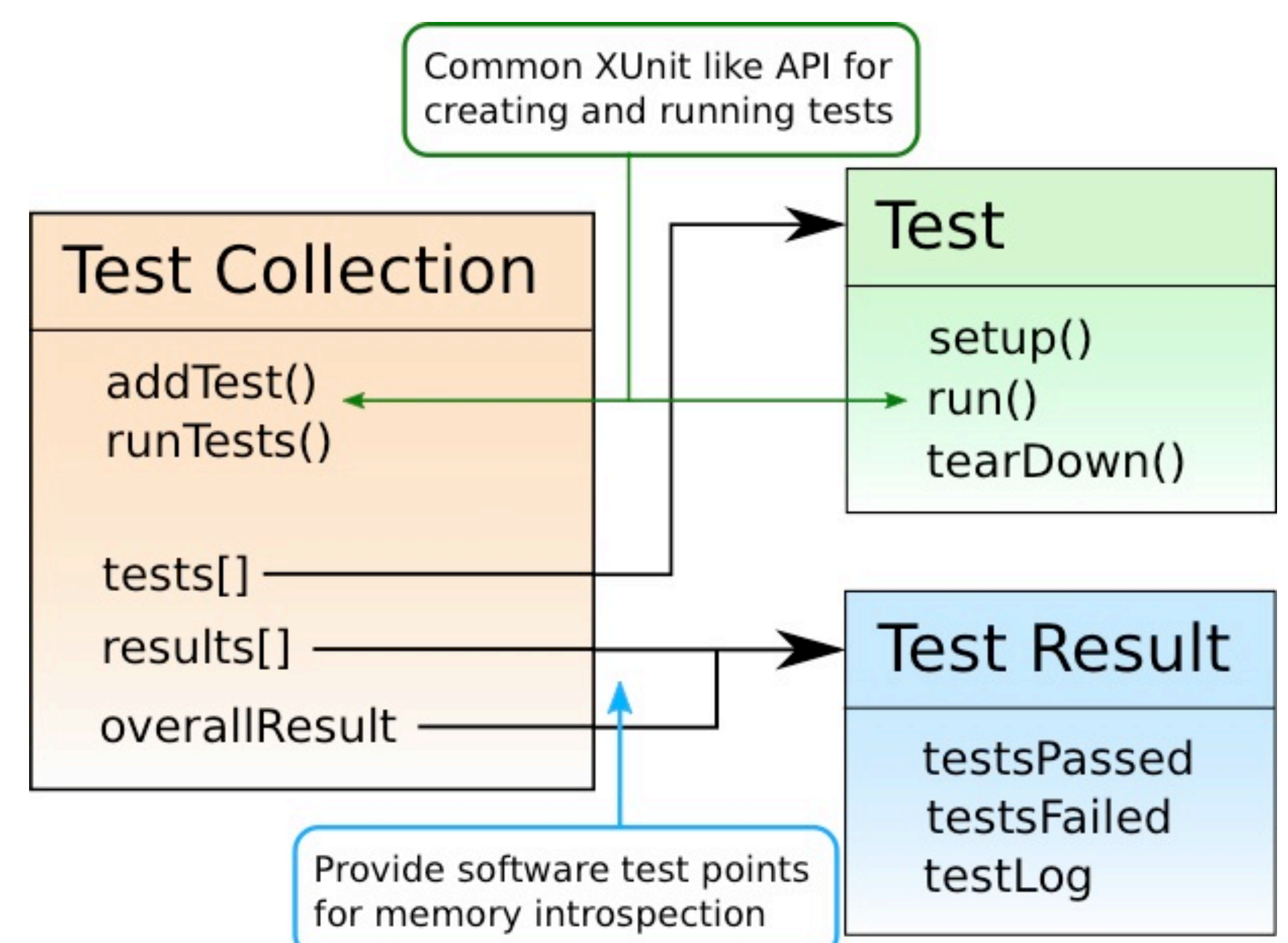
Framework Limitations

- Virtualized environments present idealized, not real, hardware
 - Introduces potential inaccuracies into testing
 - Can be partially mitigated with hypervisor and HW pass-through
- Dynamic data may not be available for introspection
 - Locations may be unknown
 - Data may change before or while it is being observed

Architecture



In-kernel Test API



Conclusions

- The testing framework is currently being used for development
 - Provides status information before HW and memory is initialized
 - Ensures future development does not break working code
- A sample GUI using the framework is shown below
 - Uses memory introspection to retrieve information

The screenshot shows a GUI titled "Unit Tester" with a "Start" button. Below the button is a table with columns: Test Name, status, passed, failed, and message. The table lists various tests and their results. A callout points to the "Exception handling testing" row, stating: Test information and status obtained from Test API. Another callout points to the "miscTests" row, stating: Kernel Panic observed by test framework. At the bottom, a message reads: OS Panic'ed: Could not find ip_offset in except table lookup.

Test Name	status	passed	failed	message
cppLibraryTests	Initialized			
TypeInfo Test	Completed	2	1	Case3:
Exception handling testing	Running	1	0	
processManagementTests	Initialized			
ELF parser test	Completed	2		
ELF64FileCache test	Completed	2		
Process test	Completed	16	0	
memoryManagementTests	Initialized			
PageFrameMap test	Completed	4	0	
RegionList test	Completed	3	0	
Page tables tests	Completed	14	0	
miscTests	Initialized			
ArrayList test	Completed	3		